Assessing conservation priorities for insects: status of water beetles in southeast Spain

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Abstract

We propose an objective method for assessing the vulnerability of species and for prioritizing species and populations for conservation, especially insects. Species of water beetles from two Spanish provinces of the southeast of the Iberian Peninsula were ranked according to their conservation priority at the local, national and global levels taking into consideration a set of six variables: general distribution, endemicity, rarity, persistence, habitat rarity and habitat loss. Each variable was categorized into four ranks (0–3) of increasing risk for survival. Ochthebius glaber, Ochthebius irenae, Ochthebius montesi, Ochthebius albacinus and Hydraena meci were seen to be the most vulnerable, for which reason we propose they should be included in the national red list. Furthermore, O. glaber, O. irenae and O. montesi are proposed for inclusion in the IUCN red list as “Vulnerable”. These species are Iberian endemisms, with geographic ranges restricted to the southeast, and are threatened by habitat loss. Effective protection of these species requires measures directed at the conservation of their habitats. Crucial target habitats for protection in the southeast of the Iberian Peninsula include freshwater streams at medium altitudes, saline streams and endorreic lagoons.

Keywords: Water beetles; Biodiversity; Conservation priorities; Vulnerability; Southeast Iberian Peninsula

1. Introduction

The process of setting priorities for conservation, particularly at species level, has largely focused on the listing and ranking of species based on their level of threat or likelihood of extinction. A variety of methods has been developed for risk assessment, from subjective assessment and rules of thumb to analytical and simulation models.

In moving from subjective methods to simulation models, the number of taxa which can potentially be included decreases because the data requirements increase steeply (Gaston et al., 2002). Qualitative methods are simpler and less reliant on difficult-to-gather data, but suffer from a nearly complete reliance on expert opinion and present difficulties when assigning species to distinct categories of risk (Mace and Lande, 1991). On the other hand, analytical and simulation models tend to demand many data that are not readily available and may be difficult to collect, especially for some groups of invertebrates such as insects. Quantitative or semi-quantitative methods based on a few relatively easy measured variables (e.g., Cofré and Marquet, 1998; Andreone and Luiselli, 2000) resolve some of these limitations and provide an objective and repeatable assessment.

On a global scale, IUCN (2001) provides a rigorous range of categories which attempts to classify species according to their likelihood of extinction within a given period. These categories have been widely accepted throughout the world and form the basis of the IUCN Red List of Threatened Animals. However, for many groups most species would have to be classified as data-deficient and in the case of some invertebrates it is inconceivable that there will ever be sufficient data for a sensible classification (Sutherland, 2000). Therefore, it is still necessary to draw up protocols for biological diversity conservation, especially for invertebrates.

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The Mediterranean Basin is considered as one of Earth’s hotspot areas for biodiversity (Mittermeier et al., 1998; Myer et al., 2000). Of particular interest in this context is the southeast Iberian Peninsula, the most arid region of Europe, which has a rich and endemic biota (Médail and Quézel, 1997) and in which anthropogenic threats to biodiversity are increasing. Because the scarcity of surface water is a distinguishing feature of the region, aquatic ecosystems, some of which are particularly rich in rare or endemic species, are especially important. Furthermore, most of these habitats are themselves of European significance and some are unique to this region. Aquatic beetles have a high species richness in the Mediterranean region and they inhabit virtually every kind of fresh- and brackish water habitat, from the smallest ponds to lagoons and wetlands and from streams to irrigation ditches and reservoirs. Furthermore, water beetles are a well known group of insects in the Iberian Peninsula (e.g., Ribera et al., 1998; Ribera, 2000) and are one of the best known groups of insects in southeast Spain (e.g., Delgado et al., 1992; Millán et al., 1996; Delgado and Soler, 1997; Millán et al., 2001a,b; Millán et al., 2002; Sánchez-Fernández et al., 2003). However, there is a lack of overall knowledge as regards their conservation status (Ribera, 2000). A first attempt to determine the vulnerability status of water beetle species was made by Sánchez-Fernández et al. (2003) for Murcia province (Spain).

In this paper, we propose a categorization system to rank species of insects according to their conservation priority or vulnerability. We assess the conservation status of water beetles from two Spanish provinces of the southeast Iberian Peninsula. The assessment was carried out at the local level for all species and at the national and global levels for the endemic species restricted to the southeast of the Iberian Peninsula.

2. Materials and methods

2.1. Study area and data set

We assessed the conservation priorities of the water beetles from two Spanish provinces located in the southeast of the Iberian Peninsula: Murcia and Albacete (Fig. 1).

The families in which a substantial proportion of the species are linked with water in any of their developmental stages were included. Well established subspecies were also considered. The nomenclature used follows Ribera et al. (1998). In order to minimize uncertainty, species of the families Sphaeriidae, Chrysomelidae, Curculionidae, Georissidae, Scirtidae, Limnichidae and Heteroceridae were not included, owing to insufficient knowledge of their distribution and/or taxonomy.

Data on species were obtained from the literature and from fieldwork. As far as possible, all published and unpublished data presently known have been included. Field data were collected between 1981 and 2002 at 337 sites (227 and 110 localities in Murcia and Albacete provinces, respectively). Most sites were sampled at least two times. The sites selected represent the diversity of water body types present within the study area. Following Millán et al. (2002), these sampling sites were associated with habitat types according to environmental and ecological parameters. Eighteen main types of habitat were distinguished (Table 1). In all, 66 of the 144 10 × 10 km UTM grid cells of the Murcia province, and 51 of the 116 10 × 10 km UTM grid cells of the Albacete province, were covered, comprising, respectively, 46% and the 32% of the total surface.

### Table 1

<table>
<thead>
<tr>
<th>Code</th>
<th>Habitat types</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Headwater streams</td>
</tr>
<tr>
<td>2</td>
<td>Middle reach streams</td>
</tr>
<tr>
<td>3</td>
<td>Middle courses of rivers</td>
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<tr>
<td>4</td>
<td>Rivers influenced by dams</td>
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<tr>
<td>5</td>
<td>Eutrophic streams</td>
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<tr>
<td>6</td>
<td>Saline streams</td>
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<tr>
<td>7</td>
<td>Springs</td>
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<tr>
<td>8</td>
<td>Irrigation channels</td>
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<tr>
<td>9</td>
<td>Reservoirs</td>
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<tr>
<td>10</td>
<td>Irrigation pools</td>
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<tr>
<td>11</td>
<td>Karstic lagoons</td>
</tr>
<tr>
<td>12</td>
<td>Endorheic lagoons</td>
</tr>
<tr>
<td>13</td>
<td>Pools, ponds and other wetlands</td>
</tr>
<tr>
<td>14</td>
<td>Continental salt-pans</td>
</tr>
<tr>
<td>15</td>
<td>Channeled rivers</td>
</tr>
<tr>
<td>16</td>
<td>Rice-fields</td>
</tr>
<tr>
<td>17</td>
<td>Coastal salt-pans</td>
</tr>
<tr>
<td>18</td>
<td>Rocks pools</td>
</tr>
</tbody>
</table>

Fig. 1. Location map of the study area (Albacete and Murcia provinces).
Based on the literature records and the specimens examined, a database was constructed that included species identity, collecting location, collecting date, collector, and number of specimens. In all, more than 6500 available records (species/site/date records) of aquatic beetles were used in the analysis (over 3000 records in Murcia province and over 3500 records in Albacete province). A total of 226 species and subspecies of water beetles from the study area (209 from Albacete and 145 from Murcia) were included in the assessment. Of these, 32 are endemic to the Iberian Peninsula, of which 15 are restricted to the southeast (all the Baetic cordilleras, including Sierra de Alcaraz in Albacete, and some places in the southwest of the Iberian Peninsula).

2.2. Assessment of species priorities for conservation

A system to rank species according to their conservation priority or vulnerability at local, national and global scale was developed. The ranking system was based on six variables (species and habitat attributes) that take values from 0 to 3 (Table 2). The overall vulnerability score (VS) for each species was the sum of all scores for each variable, giving a total value from 0 to 18.

Species were then grouped into four vulnerability categories according to their vulnerability scores at each of the three levels (local, national and global): low (0–4); medium (5–8); high (9–13); very high (14–18). Species assigned to categories high and very high were recognized as high-priority species.

2.2.1. Assessment at local level

The local level refers to sub-national unit, such as province or other similar jurisdiction (Spanish provinces in our study). The variables included in the analysis (Table 2) were:

2.2.1.1. General distribution. Five types of general distribution (GD) range were distinguished, in accordance with Ribera et al. (1998). The highest scores were given to species with a more restricted range. The different distribution ranges, from largest to smallest, were as follows:

(a) Trans-Iberian species: present in Europe north of the Pyrenees, the Iberian Peninsula, and north Africa.

(b) Southern species: present in north Africa and in some areas of the Iberian Peninsula, but not extending north of the Pyrenees.

(c) Northern species: present in Europe north of the Pyrenees and in some areas of the Iberian Peninsula, but not in north Africa.

(d) Eastern species: present in some areas in the Iberian Peninsula and in some areas in the eastern Mediterranean region, but not in Europe north of the Pyrenees.

(e) Iberian endemic species: present only in the Iberian Peninsula, including the north face of the Pyrenees (and some areas of the extreme south of France in some cases).

2.2.1.2. Endemcity. Five types of endemism (E) were distinguished for Iberian endemic species following

Table 2

<table>
<thead>
<tr>
<th>Variables</th>
<th>Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
<td>GD</td>
<td>Trans-Iberian species</td>
<td>Northern and southern species</td>
<td>Eastern species</td>
<td>Iberian endemic species</td>
<td></td>
</tr>
<tr>
<td>E R (local or national/ global rarity)</td>
<td>No strict</td>
<td>General</td>
<td>Southeast</td>
<td>Exclusive</td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td>Rarity values of habitat types (mean) between 0 and 0.75</td>
<td>Rarity values of habitat types (mean) between &gt;0.75 and 1.50</td>
<td>Rarity values of habitat types (mean) between &gt;1.50 and 2.25</td>
<td>Rarity values of habitat types (mean) between &gt;2.25 and 3</td>
<td></td>
</tr>
<tr>
<td>HL</td>
<td>Vulnerability values of habitat types (mean) between 0 and 1</td>
<td>Vulnerability values of habitat types (mean) between &gt;1 and 2</td>
<td>Vulnerability values of habitat types (mean) between &gt;2 and 3</td>
<td>Vulnerability values of habitat types (mean) between &gt;3 and 4</td>
<td></td>
</tr>
</tbody>
</table>

*Symbols: GD, general distribution; E, endemcity; R, rarity; P, persistence; HR, habitat rarity; HL, habitat loss.
Ribera et al. (1998) and Millán et al. (2002). Similarly, the highest scores were given to species with a more restricted geographic range. The types of endemism were:

(a) Not strictly: present in Iberian Peninsula and the north face of the Pyrenees, and/or some areas in the extreme south of France.

(b) General: present only in the Iberian Peninsula but with widespread distribution.

(c) Southeast Iberia: present only in the Tertiary basin of the Guadalquivir river, with all the Baetic cordilleras (including Sierra de Alcaraz in Albacete), the Baetic and Rif internal zones, and the southwest of the Iberian Peninsula in some cases.

(d) Exclusive: present only in one of the two studied provinces (Albacete or Murcia province).

2.2.1.3. Rarity. As Gaston (1994) pointed out, rarity (R), whether expressed in terms of abundance or occupancy, is undoubtedly a major determinant of a species’ risk of extinction at the scale at which it was recognized as rare. We performed a rarity analysis based on the scheme proposed by Rabinowitz et al. (1986), which considers three different types of rarity: rarity of occupancy, rarity of individuals within areas (density rarity), and habitat specificity. In general, species with a restricted geographic range, with a low abundance and which are associated with a narrow spectrum of habitats are more vulnerable to extinction than widely distributed species, with high abundance and habitat generalist.

The local occupancy of the species were quantified as the number of 10 × 10 UTM grid cells occupied. Species were scored as having “small area of occupancy” when they occurred in a maximum of two grid cells. The local abundance of the species was evaluated as number of individuals recorded per sample. Species were scored as having “low abundance” when no more than three individuals per sample were found. The degree of habitat specificity was evaluated on the basis of the number of habitat types in which a species appears. Species were scored as having “high habitat specificity” when they occurred in a maximum of two habitat types.

2.2.1.4. Persistence. The persistence (P) of a species was evaluated as its continuity in time in the study area and determined from the date of the last record (the last capture in the study area). The period of time covered by our data was divided into four intervals of five years each. As species not collected in recent years could be very rare or be in decline, higher scores were given to species which were only collected in older intervals. This variable may offer more information regarding the vulnerability of a particular species.

2.2.1.5. Habitat rarity. Some habitat types are rarer than others, and so species that depend on these scarce habitats will be more at risk. Thus, habitat rarity (HR) was considered because species restricted to locally scarce habitats are more vulnerable to local extinction. The rarity of habitats was evaluated on the basis of the number of 10 × 10 UTM grid cells of the study area in which a habitat type occurs, taking values from 0 to 3: (0) >10 grid cells; (1) 5–10 grid cells; (2) 2–4 grid cells; (3) 1 grid cell (Table 3).

After scoring habitat types according to their rarity, the next step was to score species according to habitat types in which they occurred. For each species, habitat

<table>
<thead>
<tr>
<th>Code</th>
<th>Habitat types</th>
<th>Province</th>
<th>N # grid cells</th>
<th>Rarity value</th>
<th>Province</th>
<th>N # grid cells</th>
<th>Rarity value</th>
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<td>Albacete</td>
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<td>Murcia</td>
<td>18</td>
<td>0</td>
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<td>3</td>
<td>Middle courses of rivers</td>
<td>Albacete</td>
<td>9</td>
<td>1</td>
<td>Murcia</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Rivers influenced by dams</td>
<td>Albacete</td>
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<td>1</td>
<td>Murcia</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
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<td>Eutrophic streams</td>
<td>Albacete</td>
<td>2</td>
<td>2</td>
<td>Murcia</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Saline streams</td>
<td>Albacete</td>
<td>4</td>
<td>2</td>
<td>Murcia</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>Springs</td>
<td>Albacete</td>
<td>13</td>
<td>0</td>
<td>Murcia</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>Irrigation channels</td>
<td>Albacete</td>
<td>2</td>
<td>2</td>
<td>Murcia</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Reservoirs</td>
<td>Albacete</td>
<td>4</td>
<td>2</td>
<td>Murcia</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Irrigation pools</td>
<td>Albacete</td>
<td>3</td>
<td>2</td>
<td>Murcia</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Karstic lagoons</td>
<td>Albacete</td>
<td>4</td>
<td>2</td>
<td>Murcia</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>12</td>
<td>Endorreeic lagoons</td>
<td>Albacete</td>
<td>7</td>
<td>1</td>
<td>Murcia</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>13</td>
<td>Pools, ponds and other wetlands</td>
<td>Albacete</td>
<td>4</td>
<td>2</td>
<td>Murcia</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>Continental salt-pans</td>
<td>Albacete</td>
<td>1</td>
<td>3</td>
<td>Murcia</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Channeled rivers</td>
<td>Albacete</td>
<td>–</td>
<td>–</td>
<td>Murcia</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Rice-fields</td>
<td>Albacete</td>
<td>–</td>
<td>–</td>
<td>Murcia</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>Coastal salt-pans</td>
<td>Albacete</td>
<td>–</td>
<td>–</td>
<td>Murcia</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>Rocks pools</td>
<td>Albacete</td>
<td>–</td>
<td>–</td>
<td>Murcia</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
rarity score was taken as the mean value of all the habitat types in which it occurred (sum of scores divided by the number of habitat types). These values were aggregated in four categories, scored from 0 to 3. The highest scores were given to species detected in the rarest habitat types. As habitat rarity is of little importance in habitat generalist species, only species that occur in three or fewer habitat types were considered. A score of 0 was given directly to species that occur in more than three habitat types.

2.2.1.6. Habitat loss. Species that were once widespread can become rare or vulnerable because of habitat loss (HL) or fragmentation, for which the degree of anthropic influence upon species was also included in the analysis. For each species, habitat vulnerability to loss or degradation was evaluated from the impact on habitat types in which given species occur. The impacts considered for this study were grouped into four main types:

(a) Infrastructures: dredging and stream channelisation, drainage, urbanization and other human developments.

(b) Agriculture: impact of agricultural activity on aquatic ecosystems such as clearing land for crops, water extraction for irrigation, non-point source pollution, etc.

(c) Pollution: wastewater and industrial wastes.

(d) Other impacts: recreational use and tourism, exotic species, grazing and other human disturbances.

For each habitat type a vulnerability value was assigned based on the number of impacts types affecting more than half of the sampling sites within the habitat type. This assessment of sampling site impact was based on a review of the literature and fieldwork. The scores were as follows: (0) no impact; (1) one type of impact; (2) two types of impact; (3) three types of impact; (4) four types of impact. Some habitat types (rivers influenced by dams, eutrophic streams, irrigation channels, reservoirs, irrigation pools and channeled rivers) were not considered because they are human-made systems, and so cannot be considered as being in regression or threatened (Table 4).

For each species, the habitat loss value (HL) was calculated in the same way as the habitat rarity value (sum of scores divided by the number of habitat types). The values ranged between 0 and 4 points which were aggregated into four categories, scored from 0 to 3. The highest scores were given to species found in habitat types suffering greatest impact. Again, a score of 0 was given directly to species that occurred in more than three habitat types.

2.2.2. Assessment at national and global levels

For national and global assessment, we only took into account endemic species restricted to southeast of the Iberian Peninsula (and some areas of the southwest in some cases) found in the study area because they are potentially the most threatened.

At both levels, the variables considered were the same as those used for the local scale, but some were modified according to national and global contexts. Consequently, the data used was referred to the global population of the taxa. The basic references used to determine the species distribution were taken from the Iberian lists by provinces (Montes and Soler, 1986; Rico et al., 1990; Valladares and Montes, 1991; Rico, 1997; Valladares and Ribera, 1999), and from specific papers (see Table 5).

General distribution (GD) and Type of endemism (TE) defined at local level were adopted unaltered, and species were scored in the same way.
Rarity (R) was applied to the global population of the taxa and also included the rarity of occupancy, rarity of individuals within areas, and habitat specificity. The area of occupancy of the species were quantified as subnational units occupied (Spanish provinces). Species were scored as being of small area of occupancy when they occurred in a maximum of two provinces (10 x 10 grid cells were not used because this kind of information it is not available for aquatic beetles in the Iberian Peninsula). The abundance of a species was evaluated as the number of individuals included in each bibliographic citation or sample record. Species were scored as low abundance when no more than three individuals were found. The degree of habitat specificity was evaluated on the basis of the number of habitat types in which a species occurs. Species were scored as having high habitat specificity when they occurred in a maximum of two habitat types.

Persistence (P) was determined from the date of the last record (including bibliographic records) of each species (referring now to global population). Similarly, we considered the interval to which the last record belongs.

Habitat rarity (HR) was evaluated according to a habitat occurrence at national and global levels, and based on approximate calculations from the literature and the authors' experience. The habitat scores take values ranging from 0 to 3: (0) very common; (1) moderately common; (2) moderately rare; (3) extremely rare. Similarly, for each species, the habitat rarity score was the mean of all habitat type values in which it occurred. These values were grouped into four categories, scored from 0 to 3.

Similarly, habitat loss (HL) was evaluated according to the number of different types of impact on the habitat. The impacts considered were the same as for local ranking but according to national and global contexts.

### 3. Results

#### 3.1. Species vulnerability at local scale

All 209 species of Albacete province and all 145 species of Murcia province were ranked in descending order of conservation priority at local level. Of the 209 species of water beetles that were identified in Albacete province, none was identified as being of very high vulnerability at local level. Ten species (4.8%) were identified as of high vulnerability, 44 taxa (21%) as moderate, and the 155 remaining species (74.2%) were assigned low vulnerability status. Table 6 shows the high-priority species from Albacete province (vulnerability score of 9 or above), all belonging to the family Hydraenidae.

Similarly, of the 145 species of water beetles found in Murcia province, none was included in the category of
very high vulnerability at local level. Twelve taxa (8.3%) were identified as being of high vulnerability, 35 species (24.1%) as moderate, and the 98 remaining species (67.6%) were assigned low vulnerability status. The high-priority species in Murcia province are presented in Table 7. The families with the larger number of high-priority species were Elmidae and Hydraenidae with three species each, followed by Hydrochidae and Helocephoridae, with two species each.

The rarest habitat type in Albacete province was continental salt-pans, while the most vulnerable were the middle reach streams, following by saline streams and endorreic lagoons. Rock pools were the rarest habitat type in Murcia province, while middle reach streams and saline streams were the most vulnerable habitats (Tables 3 and 4).

### 3.2. Species vulnerability at national and global scales

The national and global scores for the six variables studied in the 15 species restricted to the southeast of the Iberian Peninsula found in the study area are presented in Tables 8 and 9. These species were principally found in three different habitat types: headwaters, middle reach streams and springs. Only a few species were located in saline streams and endorreic lagoons. As streams and springs are very common habitats in national and global terms, the species recorded in these habitats were scored 0 in HR at both scales. However, saline streams are rare ecosystems in the Iberian Peninsula and extremely rare in global terms (Moreno et al., 1996, 1997). Thus, species that occurred in saline streams were scored 2 and 3 in rarity of habitat at the national and global levels, respectively. Similarly, species found in endorreic lagoons were scored 2 in HL at national and global levels because this habitat type is rare or extremely rare at these levels.

For the variable HL, streams and springs were considered as less vulnerable habitats in both national and global contexts. Consequently, species that occurred in them were scored 0 at both scales. However, species located in saline streams were scored 3 at both national and global levels because saline streams are heavily impacted habitats in the Iberian Peninsula and in the Mediterranean region (Gagneur, 1987; Vidal-Abarca et al., 2000). Similarly, species found in endorreic lagoons were scored 2 in HL at national and global levels because this habitat type is also impacted at both levels (Green and Anstey, 1992; Millán et al., 2001a,b).
At national level (Table 8), five species, all belonging to the family Hydraenidae, were included in the category of high vulnerability: *Ochthebius irenae*, *Ochthebius glaber*, *Ochthebius montesi*, *Ochthebius albacetinus* and *Hydraena mecai*. Similarly, at global level (Table 9), the same five species were included in the category of high vulnerability. The 10 remaining species were assigned to the moderate vulnerability group at both national and global levels. The highest vulnerability scores were given to *O. irenae*, *O. glaber* and *O. montesi*, which should be considered as especially vulnerable, because of their habitat rarity, habitat loss and restricted distribution (southeast Iberian endemic species).

Among the high-priority species at the national and global levels, two groups of vulnerable species could be distinguished. A first group included those taxa that are known from several populations and which occur in habitats under immediate threat. This is the case of *O. glaber*, *O. irenae* and *O. montesi*. A second group included very rare taxa that are known from one or few localities (less than 5) which occur in habitats which are not under immediate threat. This is the case of *H. mecai* and *O. albacetinus*.

### 4. Discussion

The system for ranking species developed herein is certainly arbitrary. However, at some point all criteria for assessing conservation priorities and for assigning scores to these criteria are also arbitrary (e.g., Millsap et al., 1990; Mace and Lande, 1991; Cofré and Marquet, 1998; IUCN, 2001). Although many variables have been proposed for assessing the conservation status of species
belong to the Hydraenidae family. Five out of 15 species endemic to the southeast of the Iberian Peninsula may be considered endangered at the national and global levels: *O. irenae, O. glaber, O. albacetinus, H. mecai* and *O. montesi*. These, therefore, are the species towards which conservation efforts should be directed most urgently. In Spain, this need for legal protection can only be realized if these species are included in the National Catalogue of Threatened Species, in the category of “sensitive to habitat alteration” and in Appendix II of the Habitat Directive (Directive 92/43/CEE) “Animal and plant species of community interest whose conservation requires the designation of special areas of conservation”.

Among the species of high vulnerability, all but two (*H. mecai* and *O. albacetinus*) are strong candidates for inclusion in the IUCN red list. Although *H. mecai* is a scarce and, apparently very localized species, it has recently been discovered in one locality of the Sierra de Alcaraz, in Albacete province (Millán and Aguilería, 2000) but there is still insufficient information available about its distribution. On the other hand, *O. albacetinus* is known from few localities in the Sierra de Segura and Sierra de Alcaraz, in the provinces of Albacete and Jaén. Thus, the area of occupancy of this species is very small. However, *O. albacetinus* occurs in headwater streams, which is a common and relatively unaltered habitat in the distribution area of this species.

*O. glaber, O. irenae, and O. montesi*, on the other hand, also have restricted ranges, but they principally colonize rare threatened ecosystems (hypersaline streams, endorreic lagoons, and hyposaline coastal streams, respectively) and, therefore, their inclusion on the IUCN red list seems fully justified. We propose its inclusion in the category “Vulnerable” under criterion B2 (area of occupancy estimated to be less than 2000 km²) and subcriteria a (severely fragmented or known to exist at no more than 10 locations) and b(iii) (continuing decline in area, extent and/or quality of habitat): VU B2ab(iii).

*O. glaber* is known from a few areas in the south and east of the Iberian Peninsula, where it is distributed among seven Spanish provinces: Albacete, Murcia, Córdoba, Alicante, Jaén, Valencia and Cádiz, occurring in hypersaline streams (generally associated with marl soils) with a salinity of up to 120 g/l, occasionally reaching 300 g/l. Many saline and hypersaline streams are disappearing through the over-exploitation of aquifers, non-point source pollution processes, and water sweetening (Gagneur, 1987; Martínez-Fernández et al., 2000; Pulido-Bosch et al., 2000; Vidal-Abarca et al., 2000). The known area of occupancy of this species (sum of the 10 × 10 grid cells it occupies) is around 1100 km².

*O. irenae* is known from only two localities. The area of occupancy of this species is perhaps only 200 km² and
restricted to Albacete province. The principal population (with several tens of individuals recorded) of this species was found in an endorreic lagoon with mesosaline waters (Salinas de Pinilla). We also found two exemplars in a karstic and freshwater lagoon (Laguna del Alboraj), but this record must be considered as representing a sporadic or unusual presence. The continuous loss of mesosaline lagoons in the province of Albacete (Millán et al., 2001a,b, 2002), and, in general, in the Iberian Peninsula (Cirujano, 1990; Green and Anstey, 1992) must be taken into account when evaluating the vulnerability of this species. For example, 60% of the endorreic lagoons in Andalusia (South of Spain) have been drained this century (Green and Hughes, 1996).

*O. montesi* is known from a few areas in the south and southeast of the Iberian Peninsula. These populations are distributed among four Spanish provinces: Murcia, Alicante, Málaga and Almeria, where they mainly occur in saline streams (generally hyposaline and mesosaline waters near the coast). The area of occupancy of this specie is around 700 km². Furthermore, their habitat is threatened in the same way as the habitat of *O. glaber*.

On the other hand, among the species of moderate vulnerability, *Limnetebius millani*, *Ochthebius bellieri* and *Hydraena manfredjaechi* some are good examples of potentially vulnerable species with restricted distributions.

As Ribera (2000) pointed out, the inclusion of long lists of inconspicuous species in red lists is questionable, since these species are rarely suitable for special action. Thus, best option would be measures directed towards the conservation of the habitat (e.g., through the Natura 2000 Network). Thus, based on the habitat types in which vulnerable species occur, it emerges that urgent priority should be given to effectively protecting prominent habitats for several species. Crucial target habitats for protection in the southeast of the Iberian Peninsula are: (i) freshwater streams at medium altitudes; (ii) saline streams; (iii) endorreic lagoons. Conservation actions for priority species should focus on these habitats. Furthermore, effective protection at local scale (Murcia province) of *Ochthebius* and *Hydraena* genera or even Hydraenidae family could reduce the problem of their small size, lack of public appeal and reduced morphological diversity, and may be regarded as a good complement to habitat protection.

Because the natural world is extremely dynamic and our knowledge of the distribution, abundance, and basic biology of species and ecological communities is imperfect, but continually improving, biodiversity status rankings must be viewed as working hypotheses based on the best available information. Ranks are continually reevaluated as new populations are discovered, known populations are exterminated, or new or better information on overall status, trends or threats becomes available. This is especially true in the case of insects, for which any increase in knowledge concerning particular taxa could result in a change in conservation category. In this regard, the analysis here performed for aquatic beetles from the southeast of the Iberian Peninsula should be considered as a first step in a process that should be iterated in the light of new data.

Although the vulnerability analysis proposed still requires some decisions based on the expertise of the authors, it certainly represent a significant step towards a quantitative and objective method for prioritizing species and populations for conservation, especially in the case of insects. In addition, our analysis provides some interesting insights into the threats and conservation priorities of several taxa restricted to the Iberian Peninsula.

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References


